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Towards a Web 2.0 Based Practical Works Management System at a Public University: Case of Sultan Moulay Slimane University

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Abstract**—**The goal of engineering education is to prepare students to cope with problems of real devices and systems. Usually there are not enough devices or time for conducting experiments in a real lab. Other factors that prevent the use of lab devices directly by students are inaccessible or dangerous phenomena, or polluting chemical reactions. The technology brings additional strategies of learning and teaching, there are two types of online labs, virtual and remote labs RL. We present an example of a successful development and deployment of a remote lab in the field of engineering education, integrated in the Moodle platform, using very low-coast, high documented devices and free software. The remote lab is user friendly for both teachers and students. Our web 2.0 based user interface would attract and motivate students, as well as solving the problem of larger classes and expensive lab devices.

Keywords**—**Remote lab, online learning, Moodle, Arduino, SMSU, lab experimentation, engineering education, online engineering education.

I. Introduction

AFTER having graduated, engineering sciences laureates will be faced with solving real problems, and they will work with technical equipment, so the goal of engineering education is to prepare students to cope with problems of real devices and systems [1]. The problem is: whether they were in touch with those equipment during their studies. The engineering students spend the biggest part of their time in amphitheater following the course's content, more time trying to understand and in some cases with no experimental session for what they learn. To change this fact and develop practical skills during their studies, engineering students must past more time in labs than amphitheaters listening to the professor explaining a scientific course. Being in touch with lab devices is the efficient way to learn sciences. Some factors such as the number of students per group, the type of current labs are barriers to the learning of sciences. To deal with this fact, we integrate remote labs into learning to develop technical competences for students and being able to use lab devices remotely. This solution in the learning would attract and motivate students, as well as be user friendly on the one hand [1], on the other hand the RLs are designed for universities that they cannot provide all the lab equipment [2].

The paper has five parts, in the first chapter, a general study about the use of labs in higher engineering education, and showing an overview of online tools used in education. The second chapter gives an experimental online learning model including remote labs. The third chapter details the structured layered architecture for our RL. The fourth chapter presents an example of remote lab developed in Sultan Moulay Slimane University SMSU. Full results and discussions are reported in the fifth chapter then a conclusion.

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II. A General Study about the Use of Labs in Higher Engineering Education

Due to the fast development of engineering technologies and pressure of markets, industries expect from the educational institutions that engineering students during their studies are able to perform devices and lab equipment while conducting experiment, observing phenomena, testing new ideas, analyzing by themselves, and reaching their own conclusions. Hands-on labs are important for engineering students so they can know how equipment work by themselves for their future professional world.

Such labs work with real experimental expensive devices, demand time and physical presence for both students and teachers. Furthermore, it is necessary to upgrade the lab components frequently. Moreover, experiments are prepared for larger classes of students that demand higher financial investments [3]. Practical work in hands-on labs is generally considered as being a major part of sciences and engineering education, student can directly touch and see the lab equipment; this full impression of being in the lab cannot be provided in some reasons, so it is a challenge to make practical work available for students in higher education environment. That is why remote labs are called by Aktan the “Second Best to Being There” [4]. Furthermore, there are good reasons to provide students with remote labs too.

A. Studying at a Distance from the Institution

Most of the practical works associated are provided locally in the institution, remote experiments in a distance learning context offer the possibility of access to real experimental devices.

B. Expensive Equipment Required

Some lab devices are expensive and in the cases where this equipment is used only for a part of the year, it is possible to share it between institutions using remote lab.

C. Lab Space and Devices Not Enough for the Large Number of Students

Remote lab provides experiments 24/7 over the Internet. In this way, the same device can be used by a large number of students using time organizer for students. Thus, universities are lately strongly engaged to introduce modern technologies and online courses for learning. They are advocating for investing more in modernizing engineering labs. In this research, we are trying to answer to the question of how to develop a RL so that it is going to be an efficient alternative of real lab experiments. The next chapter presents the principle of a web 2.0 based RL.

III. Web 2.0 Based Online Experimental E-Learning

The term "Web 2.0" first became reputable after the O'Reilly Media Web 2.0 conference *[5]*. Web 2.0 the second generation that facilitate communication and information sharing, secure connectivity and collaboration on the World Wide Web. Wikipedia, Gmail, YouTube, and Facebook are some examples of web 2.0 websites. Ajax is the richest media technique used to develop Web 2.0 websites, it stands for Asynchronous JavaScript and XML.

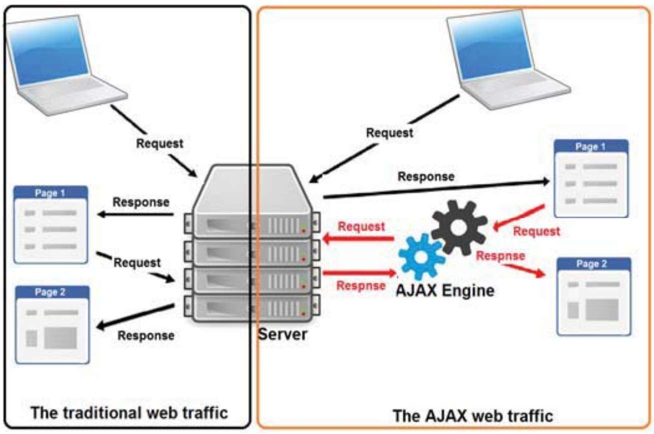

Fig. 1 Traditional and Ajax web traffic

Ajax is a development technique that combines multiple web technologies to create interactive Web applications. With AJAX the page is loaded entirely one time. The engine displays the information without reloading the whole page, only small pages are requested and sent to the browser as shown in Fig. 1.

Using Web 2.0 concepts to develop a remote lab is a new concept. The proposed framework comprised of 3 main elements (Fig. 2)

A. Educational or Pedagogical Design

To create a RL with pedagogical support, we should answer this question: do existed RLs add a value to pedagogical terms in engineering education? To evaluate the pedagogical effectiveness of RLs, a set of procedures are provided as: (1) a general introduction for each course introducing to the learner a short set of necessary theoretical information. (2) An open questionnaire on the subject before and after the experiment for ideas which need to be considered in the future. (3) Interviews with students and teachers about learning with and without RLs.

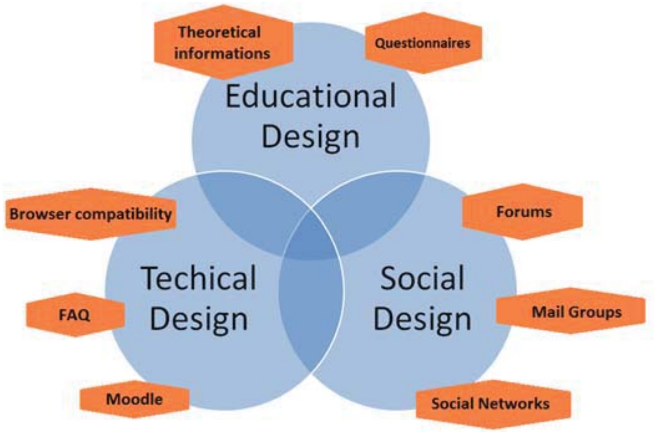

Fig. 2 Remote Lab: Pedagogical, Technical and Social Design

B. Technical Design

The RL is integrated in Moodle platform; it is designed for both students and teachers, so complexity level is very low, attractive and easy to use. The RL is a web 2.0 based platform, so it is accessible via a web browser, it is tested and worked for many web browsers and different screen resolutions. Moreover, the platform design and code are well structured for easy maintenance and for adding new experiences and online courses. Furthermore, we expect to create Frequently Asked Questions (FAQ) in Moodle to show how to conduct an experiment technically. The project team discusses the problem of traffic, so we use the Moodle Organizer tool to organize for each group the access to the RL platform.

C. Social Design

Learning life cycle does not end after understanding and doing the experiment, conversations between learners can be efficient to help solving problems. Moreover, knowledge management generally refers to how organizations create, retain, and share knowledge [6]. For this reason, we use Moodle forum for discussion and Facebook page for sharing exercises and solutions.

It is now clear the subject of the research; we present architecture of the platform that we developed for our RL in the next chapter.

IV. The Structured Layered Architecture Ensuring Communication between the User-Interface UI for the Remote Experimentation and the Computing Environment for Human Learning

We present the three layers of our global architecture, detailing functional and organizational characteristics of each layer (Fig. 3).

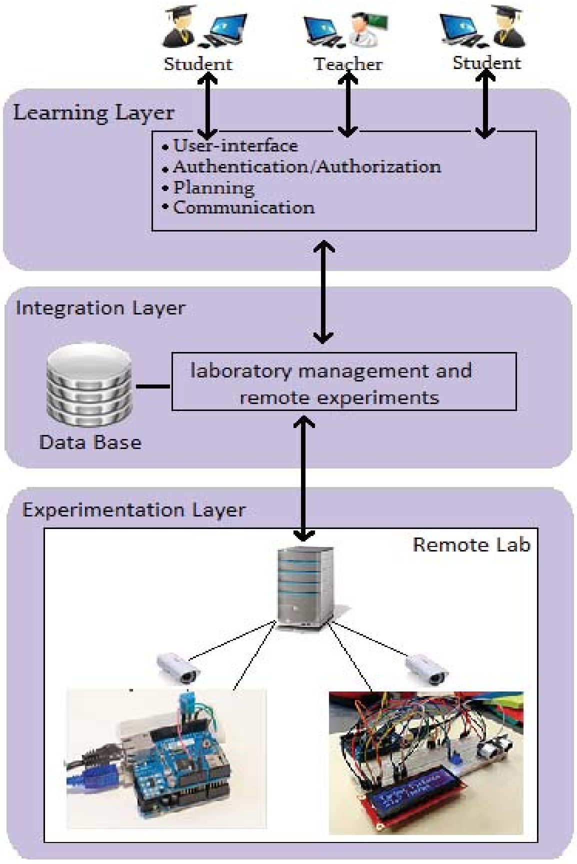

Fig. 3 The three-layer architecture of the remote lab

Our proposals provide the following advantages to the Learning Layer: (1) It ignores the technical details of instrumentation devices of RLs. (2) It has an abstract view of the lab elements in order to exploit them in a transparent way. (3) It provides UI of learning, conception, and monitoring online experiences. (4) The location of the RLs is not important for the Learning Layer.

The Experimentation layer provides an interface of unique and homogeneous operation for any experimentation object. Thus, it homogenizes and simplifies the instrumentation tools while keeping the independency of online learning environments.

The Integration layer forms the core of the architecture, because it implements all the intelligence and the complexity of lab management, resources and experiences. This layer provides transparent communication between the learning and experimentation layers.

A. The Use Case Diagram

The database is a main component of the integration layer, the figure below shows the use case diagram for the case study (Fig. 4).

B. Activity Diagram

We have six participants in our activity diagram (Teacher, Student, Learning Platform, Web Application, Arduino, and Real Practical Work). The activities of the diagram are as shown in Fig. 5.

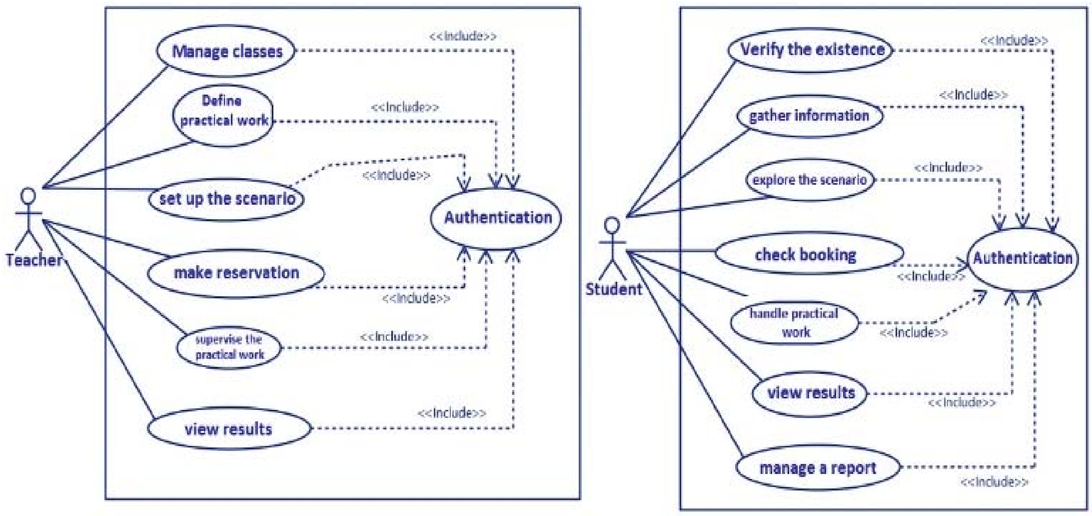

Fig. 4 The use case diagram [8]

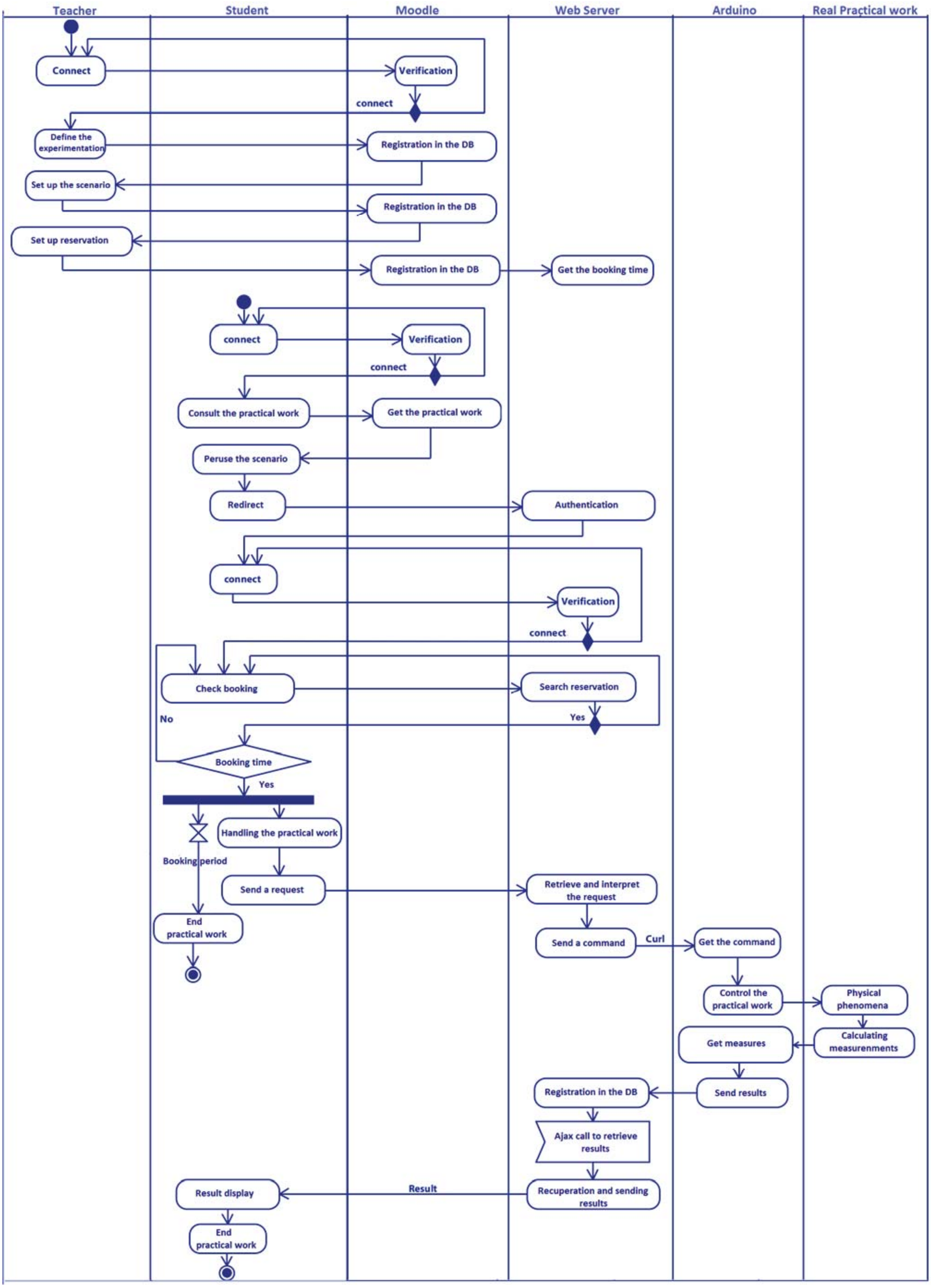

Fig. 5 The activity diagram [8]

V. Remote Lab of SMSU

For illustration, we will present a web 2.0 based remote lab that is planned for the engineering students in the field of electronics and sensors and which was developed at the SMSU, Polydisciplinary Faculty. The aim is offering to engineering students and learners a second way to conduct an experiment without being in a real lab. The web lab is designed and integrated in the framework Moodle which includes user management and privileges for each user.

The access to the platform of the remote lab is enabled only for registered users. The registration is free and it is possible to create an account or demand registration to Moodle admin. Besides, the platform contains the courses and the scenarios of remote experiments.

A. First Access to the SMSU Platform

FAUSMS "First Access to the Sultan Moulay Slimane University" is a web portal that we developed to help new students on the first access to the SMSU (Practical Information, Pre-Registration, Placement Test, Terms of use, etc.) while creating a secure space protecting both data from the institutions of the University and student information. The registration in the FAUSMS platform is essential for administrative access to the university faculties. This portal is accessible from any computer connected to the Internet inside and outside the campus. We present the number of students' registered via the FAUSMS platform in the Polydisciplinary Faculty Beni Mellal in 2015.

TABLE I
NUMBER OF STUDENTS PRE-REGISTERED TO THE FAUSMS PLATFORM IN 2015

	Number of students	**% of students**
Economics and Management	1428	40%
Life Sciences	976	27%
Physics Sciences	549	15%
Private Law (French section)	410	12%
Chemistry Sciences	145	4%
Applied Mathematics	84	2%

Table I shows that about 49% of students are future engineers and they all used the FAUSMS platform to access to the Polydisciplinary Faculty, which allows us to conclude that students are familiar with online tools and introducing online remote labs into learning is the most important step to evolve distance learning in Moroccan universities.

B. Remote Lab Architecture and Principle of Operation

RL is composed of 2 perimeters: web perimeter and the perimeter of the institution specifically the local faculty network. In the local network perimeter, two web servers are set up; the first contains the learning platform that represents the university datacenter, where all data are stored. The second contains the UI platform of RL that will allow students to manipulate the practical work remotely. Moreover, we set up several practical works; each one has its own web camera, which shows the device for manipulating the experiment. Moreover, we use Arduino board as it is a popular, high-documented, low-coast and open source microcontroller, and connected to inexpensive sensors to measure physical or chemical variables (Fig. 6).

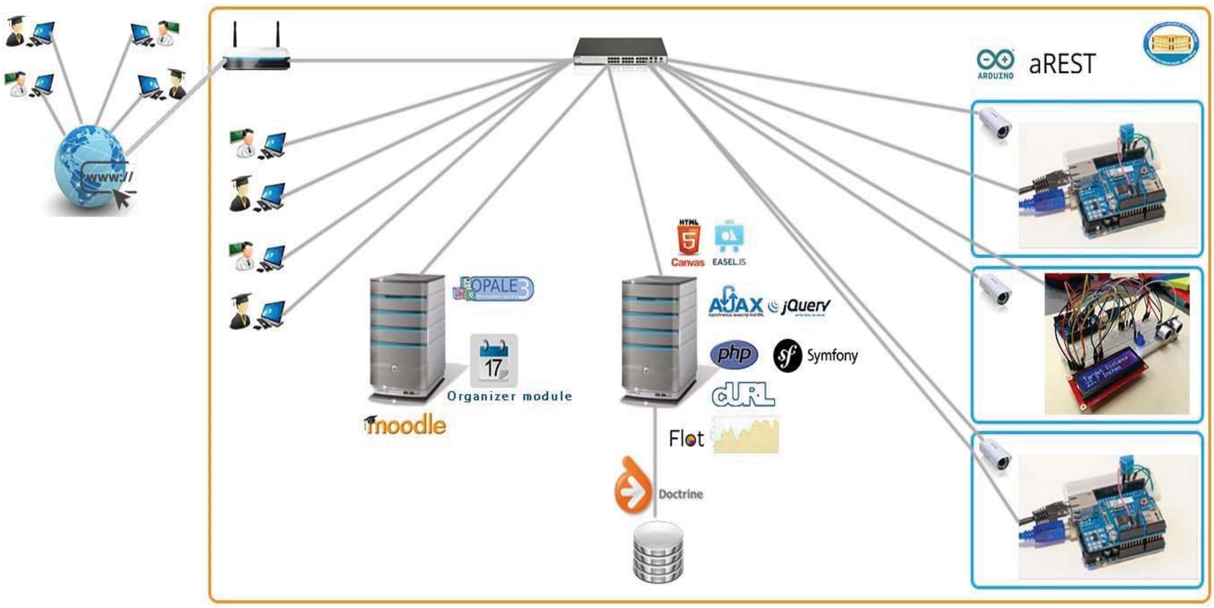

Fig. 6 Remote Lab Architecture, Technology and Tools [8]

We integrated a booking tool (Moodle Organizer) for the reservation of the remote experiment implementation. The user can make his reservation for the implementation of the remote experiment. This tool is one of the most important elements for a flexible use of the RL, because it organizes access to the experience such that only one user can manipulate a remote device at the booking date and time (Fig. 7).

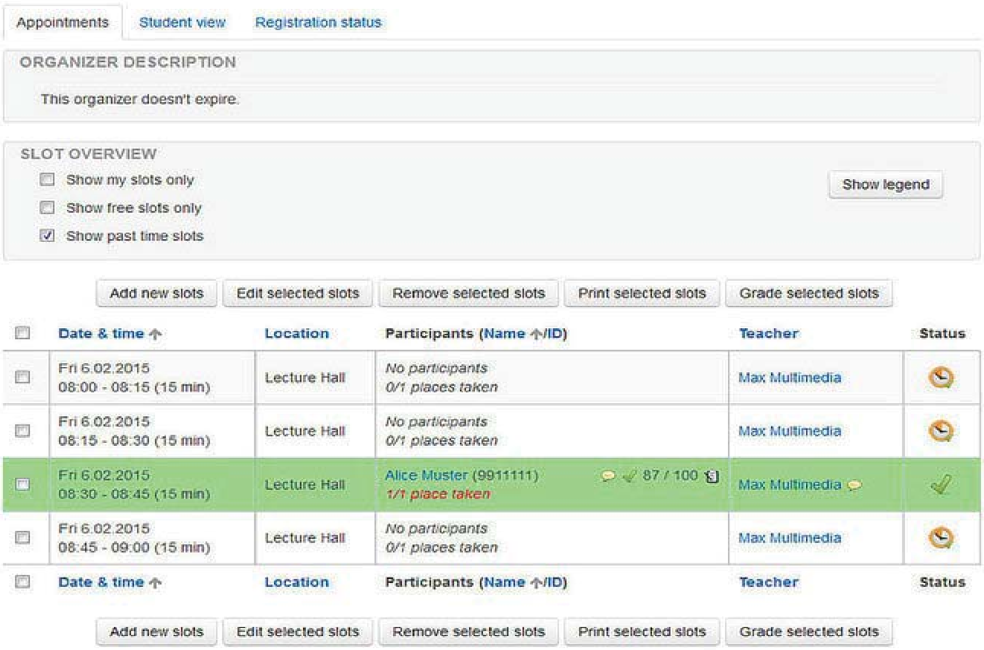

Fig. 7 Remote lab booking tool (Moodle Organizer)

C. An example of Remote Lab Experiment

After login, a list of reservations is shown that contains all information necessary and a link for each one that will lead the user to the remote experiment page. The RL web pages provide the possibility to change input parameters, interact with the experiment and analyze the results.

Manipulating page allows the student to realize the first schema of an experiment virtually, sliding various electronic components as shown in (1) Fig. 8. As it is shown in Section II, the web camera shows the real reactions of the experiment. This is an example of a motor wheel robot that is moving forward and backward and calculates the distance between the motor and the distance sensor; the results are shown in Section III.

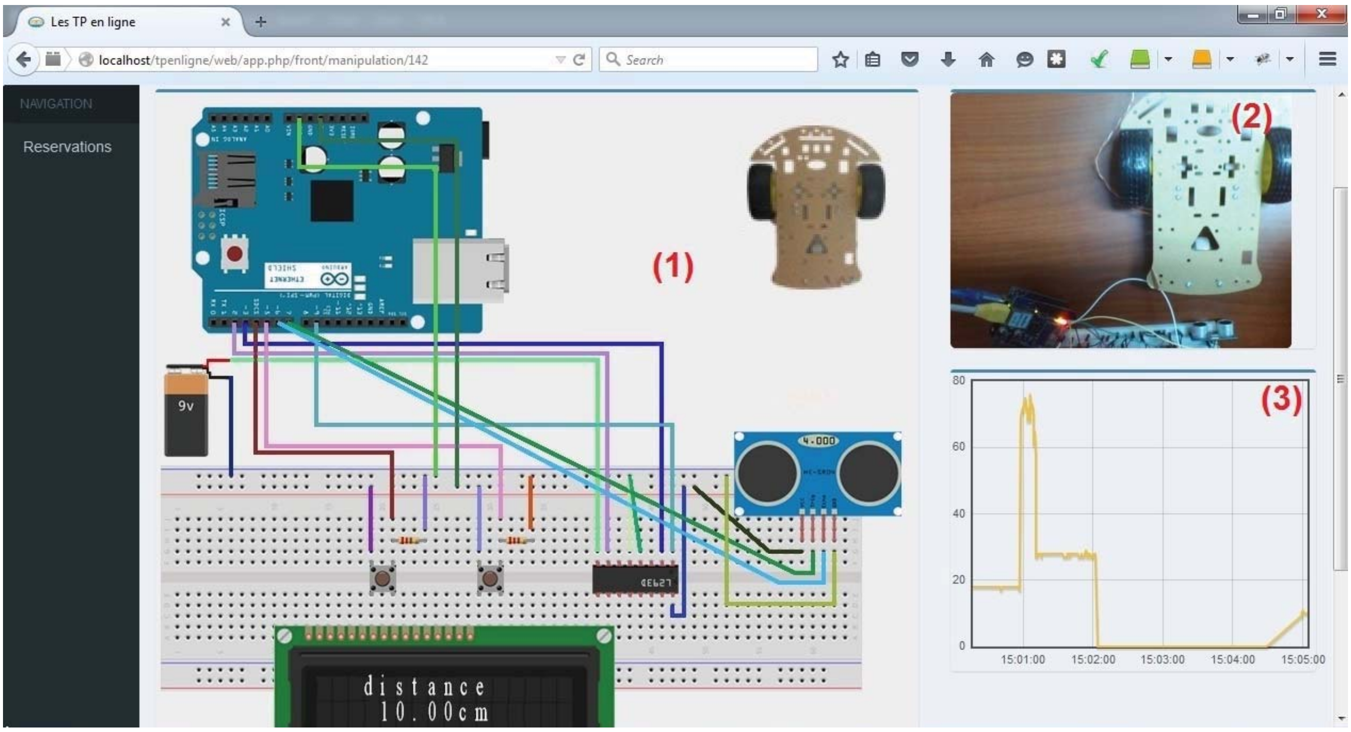

Fig. 8 The remote lab manipulation page for practical work [8]

One of the most important features of remote experimentation system in education is the system's ease of use [7], as it strongly influenced the acceptance of the RL by users. In our RL, the choice of cheap equipment and free software is due to the limited financial resources. Furthermore, it is a platform that is used in any web browser; the only thing needed is a computer connected to internet, so there is no need of an exhaustive software installation.

VI. Results and Discussions

In this section, we discuss the questionnaire which was answered by 560 students of the SMSU, with the intention of giving a general view on the degree of the use of Information and Communication Technologies ICT in high education.
To do this we have chosen the following topics:

- General information (3 questions)
- Traditional teaching (6 questions)
- The use of new technologies (4 questions)
- Tools for creating new documents (1 question)
- Remote learning (6 questions)

A. General Information

75% are students from the PF and 23% from FST then 2% from FLHS which shows that engineering students are interested by a new way of learning.

About age, 66% between 20 and 25 years, 9% are between 25 and 30 years, while 25% are under 20 years.

60% are male and 40% are.

B. Traditional Teaching

Level: The first by 54% are the 3rd year's students, 15% for each of students from the 1st and the 2nd year, 10% are students of the 2nd year of master then 6% are in the 1st year master

Domain: 83% of all students are engineering students while 17% are studying languages, law and geography.

Presence: about 70% are always present at the courses and the directed work and they are satisfied, while only 50% are always present in labs for experimentations, and 50% are rarely or never been in a lab.

We state that the students that are always in lab for experimentation only 18% of them are very satisfied or satisfied. That is an important detail that it must be considered (Fig. 9).

C. The Use of New Technologies

We asked the question: What is your level of computer use? Only 5% have a low, 27% medium and 68% have high and very high level using a computer.

82% of our students had already created numeric documents. Moreover, 98% are using emails, but only 2% they never use an email. Finally, we state that 96% of our students have their own computers. Observing these statistics, we can conclude that our students are familiar with the ICT.

D. Tools for Creating New Documents

As it is shown in Fig. 10, the majority of students use the familiar office software, a significant percentage of students use forums, animation, HTML and videoconferences.

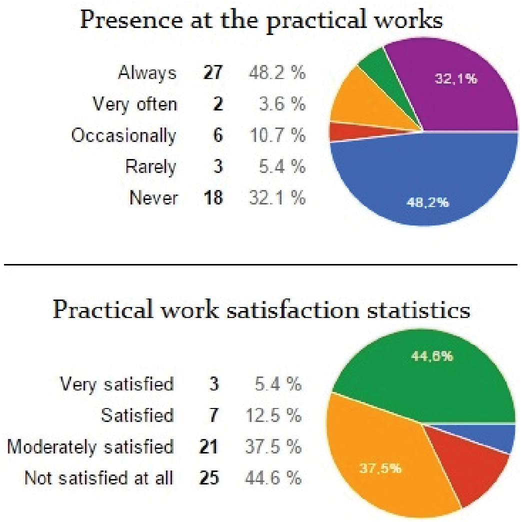

Fig. 9 Local lab presence and satisfaction statistics

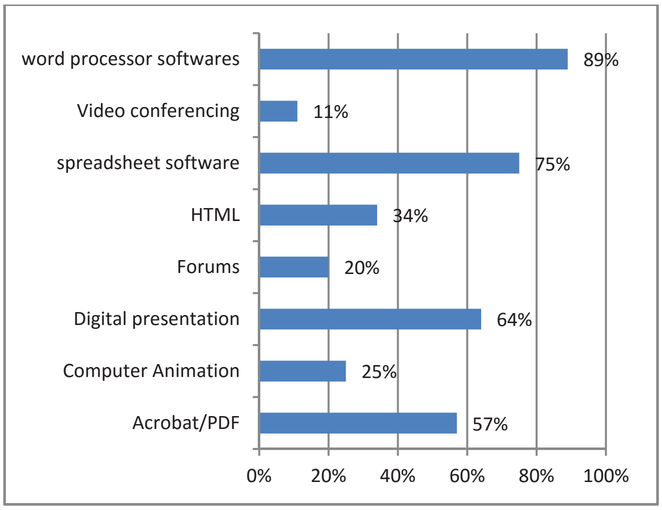

Fig. 10 Tools for creating new documents statistics

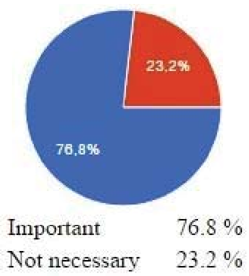

Fig. 9 Students' opinion on the RL project

E. Remote Learning

76% of our students spend more than 2h a day in front of a computer. About 34% use computer to prepare courses, but 66% prefer using classic method (paper).

We asked our students about having a real remote experimentation instead of being in a traditional lab, 77% are interested and motivated to have this experience (Fig. 9). 54% communicate with their teachers using ITC.

We state that students are generally able for remote learning.

VII. Conclusion

This project was an opportunity to put into practice the theoretical knowledge acquired during the learning process. This modest work is seen as a simple introduction in the field of RLs, there is still work to be done, improvements to be added, it must not stop at this level. The web 2.0 based user interface is user friendly that would attract and motivate students, as well as solving the problem of larger classes and expensive lab devices.

Nowadays, only a small number of RLs have been built in research projects in Moroccan education institutions, we think it will be better to bring this project to the national level, where all the universities collaborate. The future will show if our RL model will succeed in higher education learning.

The conclusion that we can come to here from the analysis of the answers is that students are not satisfied in conducting experimentation in a real lab. However, most students are familiar with the ICT. The questionnaire experience shows that students are able and ready for the new way of learning by the RL experiences.

Acknowledgment

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